

Ser. No. 10/805,841
Response to Office Action of 2/4/05
Atty Docket 200512-5

- 3 -

AMENDMENTS TO THE CLAIMS

Please amend the claims as they currently stand so that they are in accord with the following listing of the claims:

Claim 1 (original): A method of chemical species suppression for MRI imaging of a scanned object region comprising:

- acquiring K space data at a first TE;
- acquiring K space data at a second TE;
- reconstructing images having off resonance effects;
- estimating off resonance effects at locations throughout the reconstructed images; and
- determining the first and second chemical species signals at image locations of the scanned object from the acquired signals and correcting for blurring resulting from off resonance effects due to B_0 inhomogeneity.

Claim 2 (original): The method defined in claim 1 wherein the steps of acquiring K space data at the first TE and the second TE comprise acquiring signal components from first and second chemical species.

Claim 3 (original): The method defined in claim 1 further comprising acquiring K space data at a third TE.

Claim 4 (original): The method defined in claim 3 wherein the step of acquiring K space data at the third TE comprises acquiring signal components from first and second chemical species.

Claim 5 (original): The method defined in claim 1 wherein the step of estimating off resonance effects comprises generating an estimated field map.

Claim 6 (original): The method defined in claim 5 wherein the step of generating an estimated field map comprises:

Akron - 95063.1

Ser. No. 10/805,841

- 4 -

Response to Office Action of 2/4/05

Atty Docket 200512-5

- a. estimating the off resonance effects for a first location comprising:
 - i. providing a frequency,
 - ii. estimating signal components for first and second chemical species at the provided frequency,
 - iii. calculating an estimated signal of the first and second chemical species at the provided frequency,
 - iv. calculating the difference between the estimated and acquired signal at the provided frequency, and
 - v. repeating steps i.-iv. for different frequencies to find the frequency that minimizes the difference for the first location; and
- b. repeating steps i.-v. for other locations in the estimated field map.

Claim 7 (original): The method defined in claim 6 further comprising using region growing to create a frequency field map for the scanned object.

Claim 8 (original): The method defined in claim 7 further comprising determining a frequency determined region as the value of f_j that minimizes D_{local} where D_{local} takes the single minimum in the $D_{\text{local}}-f_j$ plot.

Claim 9 (original): The method defined in claim 7 further comprising expanding the frequency determined region so that the frequency field map can be created for the scanned object region.

Claim 10 (original): The method defined in claim 9 further comprising finding the correct frequency f_j at each pixel in a 'frequency to-be-determined region' which abuts the 'frequency determined' region.

Claim 11 (original): The method defined in claim 10 wherein the step of finding the correct frequency f_j comprises choosing the value of f_j at each pixel that borders the frequency

Ser. No. 10/805,841

- 5 -

Response to Office Action of 2/4/05

Atty Docket 200512-5

determined region which creates a local minima in the $D_{\text{local}}-f_j$ plot, and is the closest to the average local frequency of the neighboring pixels in the frequency determined region.

Claim 12 (original): The method defined in claim 5 wherein the step of generating an estimated field map comprises:

- a. estimating the off resonance effects for a first location comprising:
 - i. providing a frequency,
 - ii. estimating signal components for first and second chemical species at the provided frequency,
 - iii. determining whether the signal components have the same or opposite phases at the provided frequency, and
 - iv. repeating i.-iii. for another frequency if the signal components do not have the same or opposite phases; and
- b. repeating steps i.-iv. for other locations in the estimated field map.

Claim 13 (original): The method defined in claim 1 further comprising using an off resonance correction method to eliminate the effects of local B_0 inhomogeneity on the first chemical species.

Claim 14 (original): The method defined in claim 1 further comprising using an off resonance correction method to eliminate the effects of local B_0 inhomogeneity on the second chemical species.

Claim 15 (original): The method defined in claim 1 further comprising using an off resonance correction method to eliminate the effects of local B_0 inhomogeneity on the first chemical species and the second chemical species.

Claim 16 (currently amended): The method defined in claim 5 further comprising reconstructing images of the first and second chemical species based on the frequencies indicated in the

Ser. No. 10/805,841

- 6 -

Response to Office Action of 2/4/05

Atty Docket 200512-5

frequency field map at each pixel location having blurring due to the off resonance effects of local B_0 inhomogeneity.

Claim 17 (original): The method defined in claim 1 wherein the first chemical species is water and the second chemical species is fat.

Claim 18 (original): The method defined in claim 16 further comprising demodulating the first and second chemical species images with demodulation frequencies f_l and $f_l + f_s$ to create locally deblurred images of the first and second chemical species respectively.

Claim 19 (currently amended): The method defined in claim 18 further comprising reconstructing the entirely deblurred first chemical species image by combining the deblurred regions of first chemical species images from each local frequency, f_l , in the frequency field map.

Claim 20 (currently amended): The method defined in claim 18 further comprising reconstructing the entirely deblurred second chemical species image by combining the deblurred regions of second chemical species images from each local frequency, f_s , in the frequency field map.

Claim 21 (original): The method defined in claim 1 further comprising using more than one coil for obtaining the data sets using a weighted average from signals of each coil when minimum local difference between acquired signals and estimated signals is

$$D_{\text{pixel}} = |S_0 - (W'_j + F'_j)| + |S_1 - (W'_j + F'_j \exp(i\phi_{fs})) \exp(i\phi_j)| \\ + |S_2 - (W'_j + F'_j \exp(i2\phi_{fs})) \exp(i2\phi_j)|.$$

Claim 22 (original): The method defined in claim 1 further comprising acquiring a plurality of interleaves, wherein each interleave uses a different TE and the sampling density of each interleave is sufficient to create a low resolution image.

Ser. No. 10/805,841

- 7 -

Response to Office Action of 2/4/05

Atty Docket 200512-5

Claim 23 (original): The method defined in claim 22 wherein the sampling density of each component sufficiently oversamples k space to create a low resolution image of the object at that TE.

Claim 24 (new): A method to separate fat and water signals in MRI imaging of a scanned object region, said method comprising:

acquiring at least two sets of K-space data via spiral scanning before image reconstruction, wherein each said set of K-space data is acquired using a different TE from that of any other said set of K-space data;

generating a frequency field map from said at least two sets of K-space data;

performing water-fat decomposition using said at least two sets of K-space data to reconstruct a blurred water image and a blurred fat image; and

applying said frequency field map to said blurred water image and said blurred fat image to form a deblurred water image and a deblurred fat image.